What is claimed is :

1. A semiconductor device including plural kinds of transistors, the plural kinds of transistors including at least:

a first transistor provided with a first gate insulator film which includes a first insulating film constituted of first high-dielectric insulating material and has first electric film thickness and

a second transistor provided with a second gate insulator film which includes layer structure including the first insulating film and a second insulating film constituted of second high-dielectric insulating material different from the first high-dielectric insulating material and has second electric film thickness different from the first electric film thickness,

the first and the second transistors being formed on the same silicon substrate.

2. The semiconductor device according to claim 1, wherein the first and the second high-dielectric insulating material include elements with different constitution each other.

3. The semiconductor device according to claim 1, wherein the first and the second high-dielectric insulating material include elements with the same constitution and different ratio of composition each other.

4. The semiconductor device according to claim 1, wherein the first and the second high-dielectric insulating material have different crystal structure

each other.

5. The semiconductor device according to claim 1, wherein at least one of the first and the second insulating films continuously changes in the direction of film thickness in at least any one of kinds of constitutive element and ratio of composition.

6. The semiconductor device according to claim 1, wherein the first and the second high-dielectric insulating material have different density each other.

7. The semiconductor device according to claim 1, wherein the first and the second insulating films have different profiles each other with respect to density of dangling bond in the films in the direction of the film thickness.

8. The semiconductor device according to claim 1, wherein an interface layer constituted of at least any one of a silicon oxidation film, a silicon oxynitride film or a silicon nitriding film exists on interface between the first insulating film or the second insulating film, and relevant silicon substrate in at least one of the first and the second gate insulator films.

9. The semiconductor device according to claim 1, wherein the first and the second high-dielectric insulating material included in the second gate insulator film are different from each other in etching rate for wet-etching, and an insulating film constituted of insulating material with relatively high etching rate is extending on an insulating film constituted of insulating

material with relatively low etching rate.

10. The semiconductor device according to claim 9, wherein the etching rate is the etching rate for hydrofluoric acid solution.

11. The semiconductor device according to claim 1, wherein the first and the second high-dielectric insulating material included in the second gate insulator film are different from each other in etching rate for vapor phase etching, and an insulating film constituted of insulating material with relatively high etching rate is extending on an insulating film constituted of insulating material with relatively low etching rate.

12. The semiconductor device according to claim 11, wherein the etching rate is the etching rate for vapor phase etching by fluorine radical.

13. The semiconductor device according to claim 1, wherein the layer structure including the first insulating film and the second insulating film comprises a layer modulated in composition in the direction of film thickness, underneath region of the layer being formed with a first insulating film constituted of the first high-dielectric insulating material and upper region of the layer being formed with a second insulating film constituted of the second high-dielectric insulating material.

14. The semiconductor device constituted of at least;
first insulating film structure which includes a first insulating film

constituted of first high-dielectric insulating material and has first electric film thickness and

second insulating filmstructure which includes layer structure including the first insulating film and a second insulating film constituted of second high-dielectric insulating material different from the first high-dielectric insulating material and has second electric film thickness different from the first electric film thickness,

the first and the second insulating film structure being formed on the same semiconductor substrate.

15. The semiconductor device according to claim 14, wherein the first and the second high-dielectric insulating material include elements with different constitution each other.

16. The semiconductor device according to claim 14, wherein the first and the second high-dielectric insulating material include elements with the same constitution and different ratio of composition each other.

17. The semiconductor device according to claim 14, wherein the first and the second high-dielectric insulating material have different crystal structure each other.

18. The semiconductor device according to claim 14, wherein at least one of the first and the second insulating films continuously changes in the direction of the film thickness in at least any one of kinds of constitutive

element and ratio of composition.

19. The semiconductor device according to claim 14, wherein the first and the second high-dielectric insulating material have different density each other.

20. The semiconductor device according to claim 14, wherein the first and the second insulating films have different profiles each other with respect to density of dangling bond in the films in the direction of film thickness.

21. The semiconductor device according to claim 14, wherein the semiconductor substrate is constituted of silicon substrate, and an interface layer constituted of at least any one of a silicon oxidation film, a silicon oxynitride film or a silicon nitriding film exists on interface between the first insulating film or the second insulating film, and relevant silicon substrate in at least one of the first and the second gate insulator films.

22. The semiconductor device according to claim 14, wherein the first and the second high-dielectric insulating material included in the second insulating film structure are different from each other in etching rate for wet-etching, and an insulating film constituted of insulating material with relatively high etching rate is extending on an insulating film constituted of insulating material with relatively low etching rate.

23. The semiconductor device according to claim 22, wherein the etching

rate is the etching rate for hydrofluoric acid solution.

24. The semiconductor device according to claim 14, wherein the first and the second high-dielectric insulating material included in the second insulating film structure are different from each other in etching rate for vapor phase etching, and an insulating film constituted of insulating material with relatively high etching rate is extending on an insulating film constituted of insulating material with relatively low etching rate.

25. The semiconductor device according to claim 24, wherein the etching rate is the etching rate for vapor phase etching by fluorine radical.

26. The semiconductor device according to claim 14, wherein the first and the second insulating film structure are included in different kinds of first and second semiconductor elements which are formed on the same semiconductor substrate and contact with the semiconductor substrate surface.

27. The semiconductor device according to claim 26, wherein the first and the second semiconductor elements are of the type of field effect transistor, and the first and the second insulating film structure are provided for electrically separating an electrode for controlling electric field from the semiconductor substrate surface.

28. The semiconductor device according to claim 14, wherein the layer

structure including the first insulating film and the second insulating film comprises a layer modulated in composition in the direction of film thickness, underneath region of the layer being formed with a first insulating film constituted of the first high-dielectric insulating material and upper region of the layer being formed with a second insulating film constituted of the second high-dielectric insulating material.

29. A semiconductor device including plural kinds of semiconductor elements, the plural kinds of semiconductor elements including at least:

a first semiconductor element provided with first insulating film structure which includes a first insulating film constituted of first high-dielectric insulating material with first etching rate and has first electric film thickness and

a second semiconductor element provided with a second insulating film structure which includes layer structure including the first insulating film and a second insulating film constituted of second high-dielectric insulating material with second etching rate different from the first etching rate, and which has second electric film thickness different from the first electric film thickness,

the first and the second semiconductor elements being formed on the same silicon substrate surface.

30. The semiconductor device according to claim 29, wherein the first and the second high-dielectric insulating material include elements with different constitution each other.

31. The semiconductor device according to claim 29, wherein the first and the second high-dielectric insulating material include elements with the same constitution and different ratio of composition each other.

32. The semiconductor device according to claim 29, wherein the first and the second high-dielectric insulating material have different crystal structure each other.

33. The semiconductor device according to claim 29, wherein at least one of the first and second insulating films continuously changes in the direction of the film thickness in at least any one of kinds of constitutive element and ratio of composition.

34. The semiconductor device according to claim 29, wherein the first and the second high-dielectric insulating material have different density each other.

35. The semiconductor device according to claim 29, wherein the first and the second insulating films have different profiles each other with respect to density of dangling bond in the films in the direction of film thickness.

36. The semiconductor device according to claim 29, wherein an interface layer constituted of at least any one of a silicon oxidation film, a silicon oxynitride film or a silicon nitriding film exists on interface between the

first insulating film or the second insulating film, and relevant silicon substrate in at least one of the first and the second gate insulator films.

37. The semiconductor device according to claim 29, wherein the first and the second high-dielectric insulating material included in the second gate insulator film are different from each other in etching rate for wet-etching, and an insulating film constituted of insulating material with relatively high etching rate is extending on an insulating film constituted of insulating material with relatively low etching rate.

38. The semiconductor device according to claim 37, wherein the etching rate is the etching rate for hydrofluoric acid solution.

39. The semiconductor device according to claim 29, wherein the first and the second high-dielectric insulating material included in the second insulating film structure are different from each other in etching rate for vapor phase etching, and an insulating film constituted of insulating material with relatively high etching rate is extending on an insulating film constituted of insulating material with relatively low etching rate.

40. The semiconductor device according to claim 39, wherein the etching rate is the etching rate for vapor phase etching by fluorine radical.

41. The semiconductor device according to claim 29, wherein the layer structure including the first insulating film and the second insulating films

comprises a layer modulated in composition in the direction of film thickness, underneath region of the layer being formed with a first insulating film constituted of the first high-dielectric insulating material and upper region of the layer being formed with a second insulating film constituted of the second high-dielectric insulating material.

42. A method for manufacturing a semiconductor device including plural kinds of transistors, wherein at least two kinds of transistors included in the plural kinds of transistors are formed on the same silicon substrate and have gate insulator films in which electric film thickness are different each other, and

wherein the semiconductor device includes, as the two kinds of transistors, a first transistor provided with a first gate insulator film including partially therein a first insulating film constituted of at least first high-dielectric insulating material, and a second transistor provided with a second gate insulator film including partially therein laminate structure of a first insulating film constituted of at least the first high-dielectric insulating material and a second insulating film constituted of second high-dielectric insulating material,

the method constituted of;

a step for forming the first and second gate insulator films and the step at least including

a step for forming layer structure including a first insulating film constituted of the first high-dielectric insulating material and a second insulating film constituted of the second high-dielectric insulating material

and extending on the first insulating film, in a first forming region for forming the first transistor and in a second forming region for forming the second transistor, both regions being selected on the same silicon substrate, and

a step for selectively removing the second insulating film while remaining the first insulating film at least in the first forming region.

43. The method for manufacturing a semiconductor device according to claim 42, wherein, in the step for selectively removing the second insulating film, the second insulating film is selectively etched and removed by wet-etching process utilizing etching solution with solution composition in which difference of etching rate exists between etching rate to the second high-dielectric insulating material and etching rate to the first high-dielectric insulating material.

44. The method for manufacturing a semiconductor device according to claim 43, wherein the etching solution is hydrofluoric acid solution.

45. The method for manufacturing a semiconductor device according to claim 42, wherein, in the step for selectively removing the second insulating film, the second insulating film is selectively etched and removed by vapor phase etching process utilizing fluorine radical in which difference of etching rate exists between etching rate to the second high-dielectric insulating material and etching rate to the first high-dielectric insulating material.

46. The method for manufacturing a semiconductor device according to claim 42, wherein the method further includes a step for forming a base insulating film constituted of at least any one of a silicon oxidation film, a silicon oxynitride film and a silicon nitriding film in the first and second forming regions, thereby forming the first insulating film on the base insulating film.

47. The method for manufacturing a semiconductor device according to claim 46, wherein, in the step for selectively removing the second insulating film, the second insulating film is selectively etched and removed by wet-etching process utilizing etching solution with solution composition in which difference of etching rate exists between etching rate to the second high-dielectric insulating material and etching rate to the first high-dielectric insulating material or the base insulating film.

48. The method for manufacturing a semiconductor device according to claim 47, wherein the etching solution is hydrofluoric acid solution.

49. The method for manufacturing a semiconductor device according to claim 46, wherein, in the step for selectively removing the second insulating film, the second insulating film is selectively etched and removed by vapor phase etching process utilizing fluorine radical in which difference of etching rate exists between etching rate to the second high-dielectric insulating material and etching rate to the first

high-dielectric insulating material or the base insulating film.

50. The method for manufacturing a semiconductor device according to claim 42, wherein, the first and the second high-dielectric insulating material are formed to have different crystal structure each other by setting such that first temperature of the substrate when forming the first insulating film and second temperature of the substrate when forming the second insulating film are different from each other.

51. The method for manufacturing a semiconductor device according to claim 42, wherein the method further includes a step for subjecting the first and the second insulating films to heat treatment after carrying out a step of forming the second insulating film, temperature of the heat treatment being set such that at least one of the first and the second high-dielectric insulating material is improved on its property.

52. The method for manufacturing a semiconductor device according to claim 42, wherein the step for forming the first and the second insulating films comprises

a step for forming the first insulating film constituted of the first high-dielectric insulating material in the first and the second forming regions and

a step for forming the second insulating film constituted of the second high-dielectric insulating material on the first insulating film.

53. The method for manufacturing a semiconductor device according to claim 42, wherein the step for forming the first and the second insulating films comprises

a step for forming the first insulating film constituted of the first high-dielectric insulating material in the first and second forming regions,

a step for forming metal film on the first insulating film,

a step for forming composition-modulated layers by subjecting the first insulating film and the metal film to heat treatment,

the heat treatment causing that a reaction occurs between constitutive element of the first insulating film and constitutive element of the metal film, a laminated body of the first insulating film and the metal film is composition-modulated in the direction of the film thickness, underneath region is constituted of the first insulating film constituted of the first high-dielectric insulating material, and upper region is constituted of the second insulating film constituted of the second high-dielectric insulating material.

54. A method for forming first and second insulating film structure with different electric film thickness each other on the same semiconductor substrate, the method including;

a step for forming layer structure including a first insulating film constituted of first high-dielectric insulating material and a second insulating film constituted of second high-dielectric insulating material extending on the first insulating film in a first selection region and a second selection region selected on the semiconductor substrate and

a step for selectively removing the second insulating film while remaining the first insulating film at least in the first selection region.

55. The method according to claim 54, wherein, in the step for selectively removing the second insulating film, the second insulating film is selectively etched and removed by wet-etching process utilizing etching solution with solution composition in which difference of etching rate exists between etching rate to the second high-dielectric insulating material and etching rate to the first high-dielectric insulating material.

56. The method according to claim 55, wherein the etching solution is hydrofluoric acid solution.

57. The method according to claim 54, wherein, in the step for selectively removing the second insulating film, the second insulating film is selectively etched and removed by vapor phase etching process utilizing fluorine radical in which difference of etching rate exists between etching rate to the second high-dielectric insulating material and etching rate to the first high-dielectric insulating material.

58. The method according to claim 54, wherein the method further includes a step for forming a base insulating film constituted of at least any one of a silicon oxidation film, a silicon oxynitride film and a silicon nitriding film in the first and the second forming regions, thereby forming the first insulating film on the base insulating film.

59. The method according to claim 58, wherein, in the step for selectively removing the second insulating film, the second insulating film is selectively etched and removed by wet-etching process utilizing etching solution with solution composition in which difference of etching rate exists between etching rate to the second high-dielectric insulating material and etching rate to the first high-dielectric insulating material or the base insulating film.

60. The method according to claim 59, wherein the etching solution is hydrofluoric acid solution.

61. The method according to claim 58, wherein, in the step for selectively removing the second insulating film, the second insulating film is selectively etched and removed by vapor phase etching process utilizing fluorine radical with mid-level vapor phase density in which difference of etching rate exists between etching rate to the second high-dielectric insulating material and etching rate to the first high-dielectric insulating material or the base insulating film.

62. The method according to claim 54, wherein the first and the second high-dielectric insulating material are formed to have different crystal structure each other by setting such that first temperature of the substrate when forming the first insulating film and second temperature of the substrate when forming the second insulating film are different from each

other.

63. The method according to claim 54, wherein the method further includes a step for subjecting the first and the second insulating films to heat treatment after carrying out a step of forming the second insulating film, temperature of the heat treatment being set such that at least one of the first and the second high-dielectric insulating material is improved on its property.

64. The method for manufacturing a semiconductor device according to claim 54, wherein the step for forming the first and the second insulating films comprises

a step for forming the first insulating film constituted of the first high-dielectric insulating material in the first and the second forming regions and

a step for forming the second insulating film constituted of the second high-dielectric insulating material on the first insulating film.

65. The method according to claim 54, wherein the step for forming the first and the second insulating films comprises;

a step for forming the first insulating film constituted of the first high-dielectric insulating material in the first and second forming regions,

a step for forming metal film on the first insulating film,

a step for forming composition-modulated layers by subjecting the first insulating film and the metal film to heat treatment,

the heat treatment causing that a reaction occurs between constitutive element of the first insulating film and constitutive element of the metal film, a laminated body of the first insulating film and the metal film is composition-modulated in the direction of the film thickness, underneath region is constituted of the first insulating film constituted of the first high-dielectric insulating material, and upper region is constituted of the second insulating film constituted of the second high-dielectric insulating material.